CLAIMS

1. Method for the analysis of surfaces, particularly for the detection of defects on semiconductor wafers, which comprises checking individual pixels of the surface under control, and detecting suspected pixels by collecting the signature of each pixel, defined by the way in which the pixel responds to the light of a scanning beam, and determining whether said signature has the characteristics of a signature of a faultless or of a pixel that is defective or suspect to be defective.

2. Method according to claim 1, comprising analyzing the signature of each pixel to determine the presence of foreign particles.

3. Method according to claim 1, wherein a pixel signature is defined by an array of signature components, each of which is a signal which corresponds to the intensity of the light scattered by the pixel in a fixed direction.

4. Method according to claim 1, comprising detecting defective or suspect pixels by a method chosen from among the group consisting of comparing the pixel signature to a master signature, comparing parameters of the pixel signature to ranges of acceptable parameters, or determining the position of the pixel signature in a statistics of such signatures.

5. Method for the analysis of patterned, semiconductor wafer having a plurality of dies thereon, which comprises providing at least one source of scanning beam, causing the beam and the wafer to move relatively to one another, sampling the light scattered by the wafer in a plurality of fixed directions, so as to obtain a plurality of pixels, each of said pixels having polar coordinates associated therewith, and transforming the polar coordinates of each suspected pixel to cartesian coordinates of the corresponding die.

6. Method according to claim 5, wherein the surface of the wafer is ideally divided into a number of zones, scanning beams are provided in a number equal to said number of zones, each scanning beam being associated with one of said zones, and the wafer is so moved that each beam scans the wafer zone associated with it, and the light produced by the response of the wafer surface to each beam is collected in a plurality of fixed directions associated with said beam.

7. Method according to claim 6, wherein the zones of the wafer are annular, concentric rings having the same radial dimension, and the wafer is rotated about its center and is shifted radially by an amount equal to said radial dimension of the rings.

8. Method for the analysis of patterned, semiconductor wafers, which comprises the steps of:

irradiating each wafer with a laser beam;

causing a relative motion of each wafer with respect to said beam, to cause said beam to scan the wafer;

sensing the light scattered by the wafer in an array of fixed directions;

converting said scattered light, in each fixed direction, to an electric signal;

sampling said electric signal at a predetermined sampling frequency, whereby to determine, at each sampling, an array of values, one value in each fixed direction, associated with a pixel of the wafer;

considering each said array of values as constituting a pixel signature;

defining the conditions which must be satisfied by all the pixel signatures of a faultless wafer;

determining whether the pixel signatures of each wafer meet the said conditions; and

classifying the pixels which meet the said conditions, as acceptable pixels and classifying the remaining pixels as "suspect".

9. Method according to claim 8, wherein, after defining the signature of each pixel, at least one signal of each signature is evaluated, and, based on said evaluation, a number of signatures is excluded from further processing.

10. Method for the analysis of patterned, semiconductor wafers, which comprises the steps of:

dividing surface of each wafer into a number of zones;

irradiating each wafer with a number of laser beams, each associated with one of said zones;

causing a relative motion of each wafer with respect to said beams to cause said beams to scan the zones of the wafer;

sensing the light scattered by the wafer in a number of arrays of fixed directions, each associated with a beam;

converting said scattered light, in each fixed direction, to an electrical signal;

sampling said electric signal at a predetermined sampling frequency, whereby to determine, at each sampling, an array of values, one value in each fixed direction, associated with a pixel of the wafer;

considering each said array of values as constituting a pixel signature;

defining the conditions which must be satisfied by all the pixel signatures of a faultless wafer;

determining whether the pixel signatures of each wafer meet the said conditions; and

classifying the pixels which meet the said conditions, as acceptable pixels and classifying the remaining pixels as suspect.

11. Method according to claim, 1, further comprising subjecting each wafer comprising suspect pixels to vector die-to-die comparison.

12. Method according to claim 1, further comprising measuring the height of the pixels to detect large foreign particles.

13. Method of die-to-die comparison of a plurality of dies in a semconductor wafer, comprising:

obtaining die coordinates of suspect pixels in each of said dies;

for each of said suspect pixels determining whether another suspect pixel exists in similar coordinates in other dies.

14. Method of detecting defects in a semiconductor wafer, which comprises:

carrying out a step of bump detection to identify suspect pixels;

obtaining die coordinates of suspect pixels in each of said dies;

for each of said suspect pixels determining whether another suspect pixel exists in similar coordinates in other dies.

15. .Method of detecting defects in a semiconductor wafer, which comprises:

carrying out a step of decay rate estimation to identify suspect pixels;

obtaining die coordinates of suspect pixels in each of said dies;

for each of said suspect pixels determining whether another suspect pixel exists in similar coordinates in other dies.

16. Apparatus for the determination of defects, particularly the presence of foreign particles, in patterned, semiconductor wafers, which comprises:

a) a stage having a support;

b) a laser source and optics generating a laser beam and directing it onto the wafer;

c) collecting optics for collecting the laser light scattered by the wafer in a number of fixed directions;

d) photoelectric sensors for generating electric analog signals representing said scattered light;

e) A/D converter for sampling said analog signals at a predetermined frequency and converting them to successions of digital components defining pixel signatures;

f) first selection system receiving the pixel signatures and their coordinates and identifying the signatures that are signatures of suspect pixels; and

h) second selection system receiving from said first selection system the signatures of suspect pixels, together with the corresponding pixel coordinates, and verifying whether each suspect pixel is indeed a defect.

17. Apparatus according to claim 16, wherein the stage comprises a turn table and scanning is accomplished by shifting the axis of rotation of the turn table.

18. Apparatus for the determination of defects in patterned, semiconductor wafers, which comprises:

a) a stage having a wafer support;

b) a laser source generating a laser beam;

c) at least one optical head designed to transmit the laser beam onto the wafer, and having a plurality of collection fiber optics arranged therein;

d) photoelectric sensors transducing the light collected by the collecting fiber optics to electric analog signals;

e) A/D converter for sampling said electric analog signals at a predetermined frequency and converting them to successions of digital components defining pixel signatures;

g) selection hardware receiving the pixel signatures and their coordinates and identifying the signatures of suspect pixels; and

h) microprocessor responsive to selection software to receive from said selection hardware the signatures of suspect pixels, together with the corresponding pixel coordinates, and evaluating said suspect pixels to single out false alarms.

19. Apparatus according to claim 18, wherein the optical head comprises at least one laser generator and wherein said collection fiber optics comprises two superimposed rings of optical fibers for collecting the light scattered by the wafer.

20. Apparatus according to claim 19, wherein each ring comprises 16 optical fibers, uniformly spaced in azimuth and having the same elevation angle, the two rings having different elevation angles,

21. Apparatus according to claim 19, wherein the laser generator produces an oblong spot size.

22. Apparatus according to claim 18, wherein the selection hardware is a custom designed electronic circuit comprising a bump detector, a decay rate estimator and a threshold comparator.

23. Apparatus according to claim 18, further comprising means for measuring the depth of the wafer pixels.

24. Optical head, comprising a cavity exposing the surface under control, at least one laser source and a plurality of optical fibers having terminals symmetrically disposed about said cavity.

25. Optical head according to claim 24, wherein the optical fiber terminals are disposed in a plurality of superimposed rings, are evenly spaced in each ring, and have axes passing through a central point of the bottom of the cavity.